Math Circles Events at MathFest 2019

Wednesday, July 31

- Exhibit Hall Opening Reception, 6:00-8:00pm
  Join SIGMAA-MCST for games, puzzles, and activities throughout the conference
  Joint with American Institute of Mathematics (AIM) and the Math Teachers' Circle Network

Thursday, August 1

- Exhibit Hall Booth, 9:00am —5:00pm
  Games, puzzles, activities, and opportunities to visit with Math Circle enthusiasts

- Contributed Paper Session, *History of Mathematics in a Math Circle*
  Jointly sponsored by SIGMAA-MCST and HOM SIGMAA (see reverse for titles and abstracts)
  Part A: 9:00—10:40am, Duke Energy Convention Center Room 237/238
  Part B: 1:30—3:30pm, Duke Energy Convention Center Room 237/238
  Organized by Amy Shell-Gellasch, Eastern Michigan University and Phil Yasskin, Texas A&M University

- SIGMAA-MCST Business Meeting, 3:30—4:30pm, Duke Energy Convention Center Room 237/238

Friday, August 2

- Exhibit Hall Booth, 9:00am —5:00pm
  Games, puzzles, activities, and opportunities to visit with Math Circle enthusiasts

- Journal of Math Circles (JMC) Jam Session, 10:10—11:30am, Duke Energy Convention Center Room 201
  Learn more about writing for this new peer-reviewed, open-access journal. JMC seeks articles documenting outreach in alignment with Math Circle core values: using worthwhile mathematical tasks, fostering problem-solving habits of mind, and building communities of mathematical thinkers and problem solvers. The workshop will introduce JMC and provide support for writing lesson plan, program summary, and professional development articles.
  Organized by Brandy S. Wiegers and Emilie Hancock, Central Washington University

Saturday, August 3

- Exhibit Hall Booth, 9:00am —12:30pm
  Games, puzzles, activities, and opportunities to visit with Math Circle enthusiasts

- Julia Robinson Mathematics Festival, 10:00am—12:00pm (Volunteer training 9:00—10:00am)
  Duke Energy Convention Center Junior Ballroom B
  Participate in a Julia Robinson Mathematics Festival (JRMF), which offers interactive and intriguing mathematical games, puzzles, problems, and activities. Participants choose which activity to engage in and for how long. Facilitators offer support but don't demonstrate or teach. Participants can discover, explore, and enjoy mathematics. This event provides an opportunity for faculty and teachers to learn how they could host a JRMF locally.
  Register as a volunteer at (https://www.jrmf.org/events/maa-math-fest/)
  Local students are also encouraged to register
  Organized by Mark Saul, JRMF; Tom Clark, Dordt College; and Jane Long, Stephen F. Austin State University

To Be Announced - Math Circles Reception, sponsored by AIM
  Details will be announced at booth and via SIGMAA listserv

Check out the Special Interest Group of the MAA on Math Circles for Students and Teachers (SIGMAA-MCST) at
http://sigmaa.maa.org/mcst/

and the Math Teachers' Circle Network (sponsored by AIM, the American Institute for Mathematics) at

https://www.mathteacherscircle.org/

Cryptography

9:00 a.m. - 9:15 a.m.

Seongchun Kwon, *University of Central Florida*

Cryptography has a rich history. It is also widely used in modern society. One of the most well-known ciphers in history is Caesar cipher. The presentation is based on the activity provided to grade 7 and 8 students in the Central Florida Math circle. This topic gave enough challenge and fun to those group of students.

Red Rock Math Circle (R^2MC)

9:20 a.m. - 9:35 a.m.

Jie Liu, *Dixie State University*

Clare Banks, *Dixie State University*

Vinodh Chellamuthu, *Dixie State University*

During 2018-2019 school year, the mathematics department of Dixie State University (DSU) initiated the very first Math Circle in Southern Utah. We are the recipients of 2018 Dolciani mathematics Enrichment Grant. The goal of this program is to encourage students' curiosity and enthusiasm about math through problem solving and interactive exploration; to provide opportunities for students to explore how math is used in real-work settings; and to increase community awareness of the importance of math while building a math community for young students. Our Math Circle is also part of the DSU STEM pipeline program serving the surrounding community. Math Circle students, DSU students, DSU faculty and staff, and community members, hand in hand formed a great circle of learning. In our presentation, we will share our experiences and the results of our Red Rock Math Circle.

Geometry Machines in Greek Antiquity

9:40 a.m. - 9:55 a.m.

Viktor Blasjo, *Utrecht University*

Greek geometry is for doers. It involved numerous mechanical contraptions for tracing curves and constructing geometrical objects. It is not for nothing that Apollonius, whose elaborate treatise on conic sections is a paragon of pure mathematics, is called "the carpenter and geometer" on the title page of one ancient manuscript. I discuss what motivated the Greeks to favor such a hands-on mode of geometrical research, and how we can utilize this for active learning and reflection today. I use historical illustrations such as the duplication of the cube attributed to Archytas, which ostensibly involves the intersection of three surfaces (a cylinder, a torus, and a cone), but which I argue was in fact intended to be executed by a machine.

Multiplication with Ancient Chinese Rod Numerals

10:00 a.m.- 10:15 a.m.

Amy Shell-Gellasch, *Eastern Michigan University*

In this talk we will introduce the Chinese rod numerals and how to preform multiplication using them. The Chinese rod numerals date back at least two thousand years. The oldest examples of bone rods are dated to about the second century BCE. The rod numerals are of interest for the clever way that place value is depicted using rod orientation. Multiplication was performed by physically manipulating the placement of rods on a place-value counting board. The beauty of this system is the physical movement of rods to show carrying and place value of each partial sum. Students can learn this system from scratch in a short time and can make rods out of simple items such as popsicle sticks. This activity combines review of place-value, an introduction to a new cultural approach to multiplication, and the kinetic reinforcement of prior knowledge of the western method of multiplication by regrouping.

Drafting Japanese Crest Designs in a Math Circle activity for High School Teachers

10:20 a.m. - 10:35 a.m.

Felicia Tabing, *University of Southern California*

Japanese family crests, called mon, are black and white, usually circular emblems associated with a Japanese family as means of identification. These designs can be very old, and have been historically used in battle to ease identification. There are thousands of different designs and variations of mon that commonly feature objects from nature, such as flowers or leaves, and geometric shapes. In their simplicity, mon designs feature a variety of symmetries, and include an example of most n-fold symmetries for n less than 20. There is an apparent connection between mon designs and the Japanese geometry problems that developed during the Edo period. In particular, an interesting problem is how to constructed mon using a compass and straightedge, as mon designers are known to utilize those tools in drafting mon. I will describe the activity I facilitated for a math circle for high school math teachers, which connects mathematics with Japanese art, history, and culture. The goal of the activity was to try to craft mon, in increasing difficulty of the design, using only their knowledge of geometry, and a compass and ruler.

The Frobenius Stamped Coin McNugget

1:30 p.m. - 1:45 p.m.
Andy Martin, *Kentucky State University*

Given two relatively prime positive integers p and q, what is the largest integer which cannot be written as mp + nq, where m and n are integers? This problem is credited to Frobenius, who did not publish it, and not to Sylvester, who did. As a recreational problem it was often couched in terms of stamps or coins, but a modern formulation counts servings of Chicken McNuggets. This talk will discuss the problem, its history, and its solution.

Problem Posing with Dice Probability in Mathematics Teacher Circles

1:50 p.m. - 2:05 p.m.
Chris Bolognese, *Columbus Academy*

In 1654, de Méré posed a problem that laid the foundation for modern probability theory. Which has greater probability? Rolling at least one six in 4 rolls or rolling at least one double-six in 24 rolls of 2 dice? Not only did this problem stump de Méré, but probability can be a challenging topic for many teachers (Batnero, Godino, & Roa, 2004). In our own Circle, many teachers express a lack of confidence in probability so such a topic is apt for exploration. Probability can be related to other K - 16 topics such as polynomial algebra and combinatorics. Given this connectedness, problems involving dice, both historical and modern, can serve as a springboard to create one's own problems through problem posing.

We will share some historical probabilistic problems, including de Méré's, rich for exploration then share a Circle session where participants explore a simple dice game called Tenzi. Each player starts with 10 fair six-sided dice. All the players roll at the same time and continue to re-roll until all 10 dice show the same value. Various strategies are considered during this play time. After playing this game, participants generate their own mathematical questions for further exploration. In particular, our participants analyze the expected number of rolls to get Tenzi using n dice and also the probability of the worst starting roll. These questions and their work will be shared as well as their takeaways relative to the teaching and learning K - 16 mathematics.

Many Worlds History of Map Coloring

2:10 p.m. - 2:25 p.m.
Skona Brittain, *SB Family School*

Map Coloring is my favorite math circle topic, as well as the one about which I include the most history. My presentation of it involves a story about a king and queen who kept having more children and increasingly difficult problems dividing their land. While the students do not need a story to be engaged, it enhances it for them. The characters' names parallel those of historical figures; then when I present the real history, they're already familiar with the names. Exposure to mathematical history gives students a sense of how idea generation, incremental progress, error correction, and cross-disciplinary germination take place. And I have seen it fostering students' images of themselves as future mathematicians. The more recent history of Martin Gardner, whom I want students to know about, also gets introduced, because of his 1975 counterexample joke. Due to the emotional investment from storytelling, particularly for my younger students, the fantasy has a happy ending, one that leads to further topological exploration.

Journal of Math Circles (JMC)

2:30 p.m. - 2:45 p.m.
Brandy S. Wiegers, *Central Washington University*
Emilie Hancock, *Central Washington University*

In the last decade, we have seen the rapid growth of Math Circles, and with it increased participation by mathematicians in scholarly thought and action around Math Circles. We believe this work necessitates more explicit professional recognition. To meet that need, we have created Journal of Math Circles (JMC). Through a double-blind peer review process, JMC offers high-quality, practitioner-focused resources for Math Circle leaders through the dissemination of local knowledge to the broader mathematical community. Articles are authored by and for mathematicians and mathematics educators who organize a wide range of community-responsive Math Circle programs for K-12 students and teachers across the country. JMC solicits original submissions capturing best practices for building and sustaining Math Circle communities that promote enthusiasm for mathematics and foster the habits of mind of mathematical thinkers and problem solvers. In this talk, we will motivate and introduce Journal of Math Circles, an open-access journal which publishes three types of articles that provide thorough, evidence-based reflection: lesson plans, outreach programs, and professional development. Our discussion will be supported with excerpts from our inaugural volume which captures the intersection of Math Circles and the work of the Global Math Project. Finally, we will provide an overview of how practitioners can write for JMC, including a discussion of our current and future efforts to support a diverse group of JMC authors in contributing to the journal.
Learn more at https://digitalcommons.cwu.edu/mathcirclesjournal/

Math Circles Based on Newton's Mathematics

2:50 p.m. - 3:05 p.m.
Robert Sachs, *George Mason University*

This talk will describe several successful math circles centered on topics related to Newton's work. This includes: Newton's method for solving polynomial equations by iteration (avoiding harder cases which use derivatives); Newton polynomial interpolation; Newton's method for finding expansions of inverse functions. These are accessible without knowing calculus and have some playful "hooks". In some sessions, I have not mentioned Newton's name until the students have made progress, in which case there is a huge satisfaction in rediscovering something done by Newton.

Exploring Infinitesimals in a Math Teachers Circle

3:10 p.m. - 3:25 p.m.
Cymra Haskell, *University of Southern California*

Calculus was originally developed in the late 17th century using the concept of infinitesimals; numbers that are greater than 0 but smaller than every positive real number. Although there was no rigorous proof that such numbers existed, for the next 200 years people used their intuition to manipulate these numbers and develop the theory of calculus. In the middle of the 19th century Weierstrass made calculus rigorous with his development of the epsilon-delta definition of a limit. With this approach there was no need for infinitesimals and the use of these numbers, whose existence was questionable, fell by the wayside. However, having been used for 200 years, it can be argued that infinitesimals may be a more intuitive approach to calculus and, if adopted, might make calculus accessible to a wider group of people.

One hundred years after Weierstrass, In the middle of the 20th century, the existence of infinitesimals was established rigorously by Robinson, so we can now rest assured that the intuitive calculations people did for 200 years are, indeed, rigorous. However, it is hard to turn around 100 years of established ritual, so the limit approach to calculus is still the default used across the world. In this session, we describe a math teachers circle activity in which we introduce K-12 teachers to infinitesimals and the hyperreal numbers. The teachers were thrilled to learn about these numbers and comfortable manipulating them intuitively. It also gave them an opportunity to explore real numbers and the relationship between mathematics and the physical world.